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EP 0490554 A2 **WO 92/21182 A1**

(58) Field of Search
UK CL (Edition L) **H4K KY4D8 KY4D8D , H4L LDSF LDSX**
INT CL^5 **H04Q 7/04**
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(54) Frequency allocation in a cellular radio system

(57) A number of base sites (10 - 16) are connected to a central processing unit (OMC) (18). The OMC has a database containing (19) base site location and frequency allocation information. The location of a new (mobile) base unit (20) is derived from a GPS receiver (21) and sent to the OMC (18). This information is compared with known location and frequency allocation information for other base sites and the new base unit and the other base sites are controlled to adopt new frequencies as a result of the comparison, thereby automatically modifying and updating the frequency allocation plan.

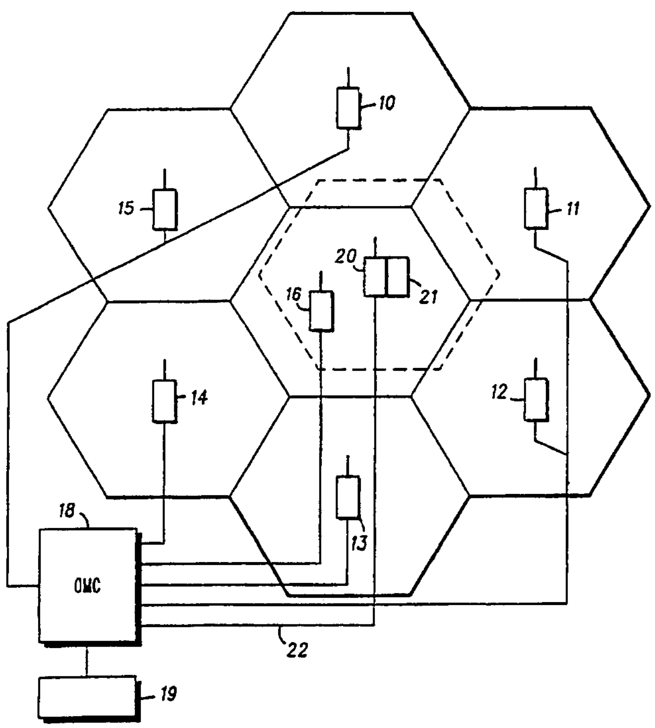

FIG.1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

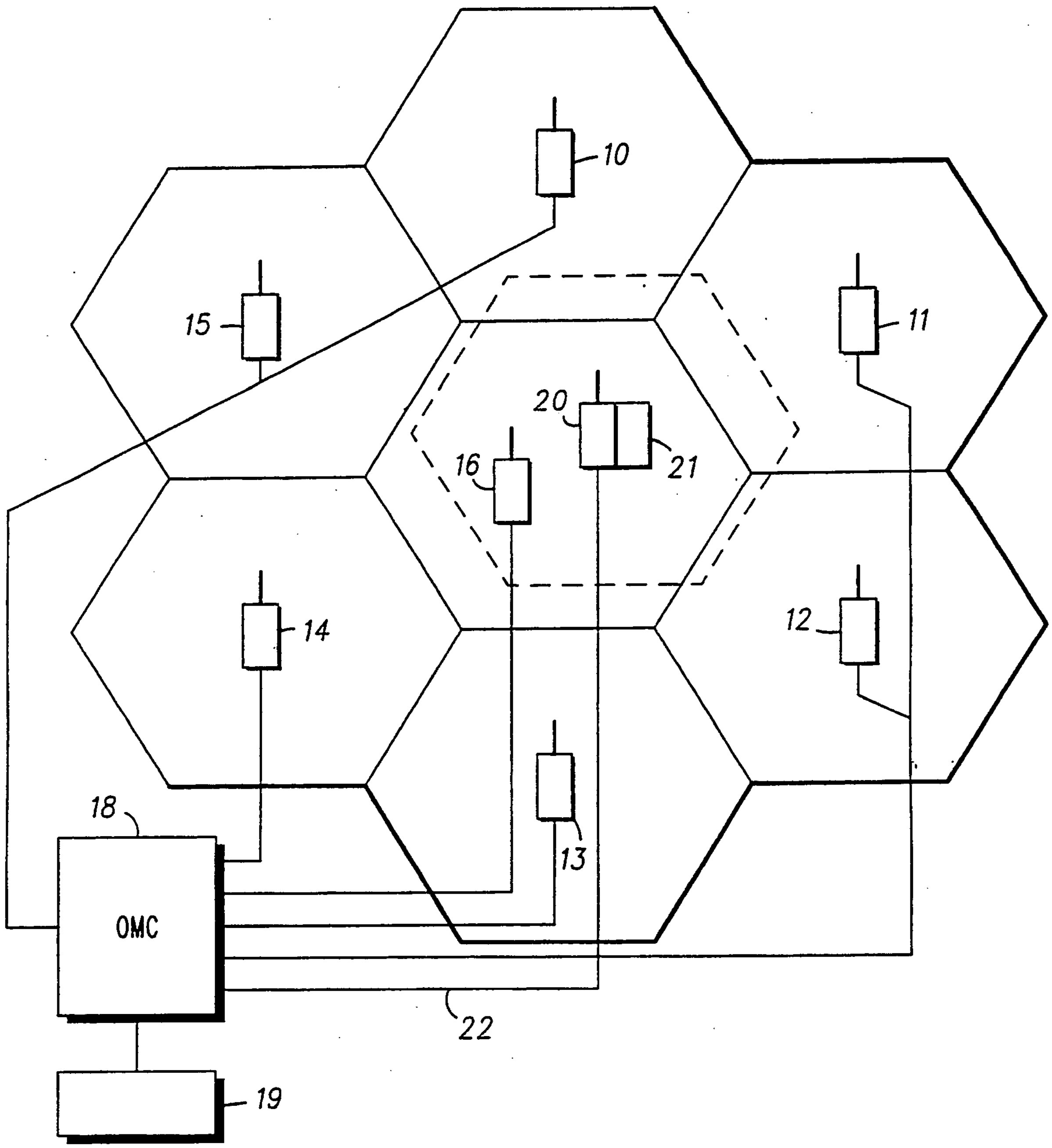

FIG.1

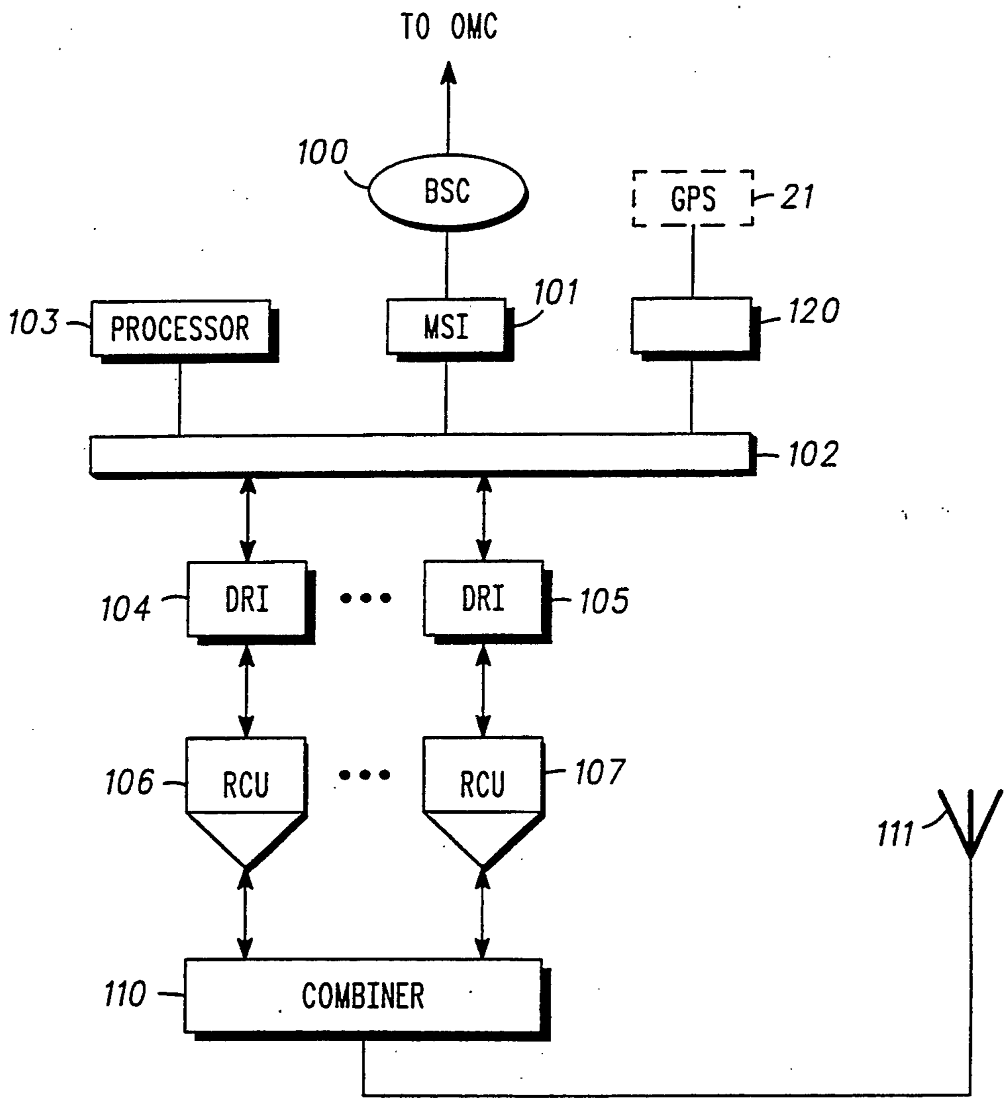
TO OMC
100
BSC
GPS
21
103
PROCESSOR
MSI
101
120
102
104
DRI
DRI
105
106
RCU
RCU
107
111
110
COMBINER

FIG. 2

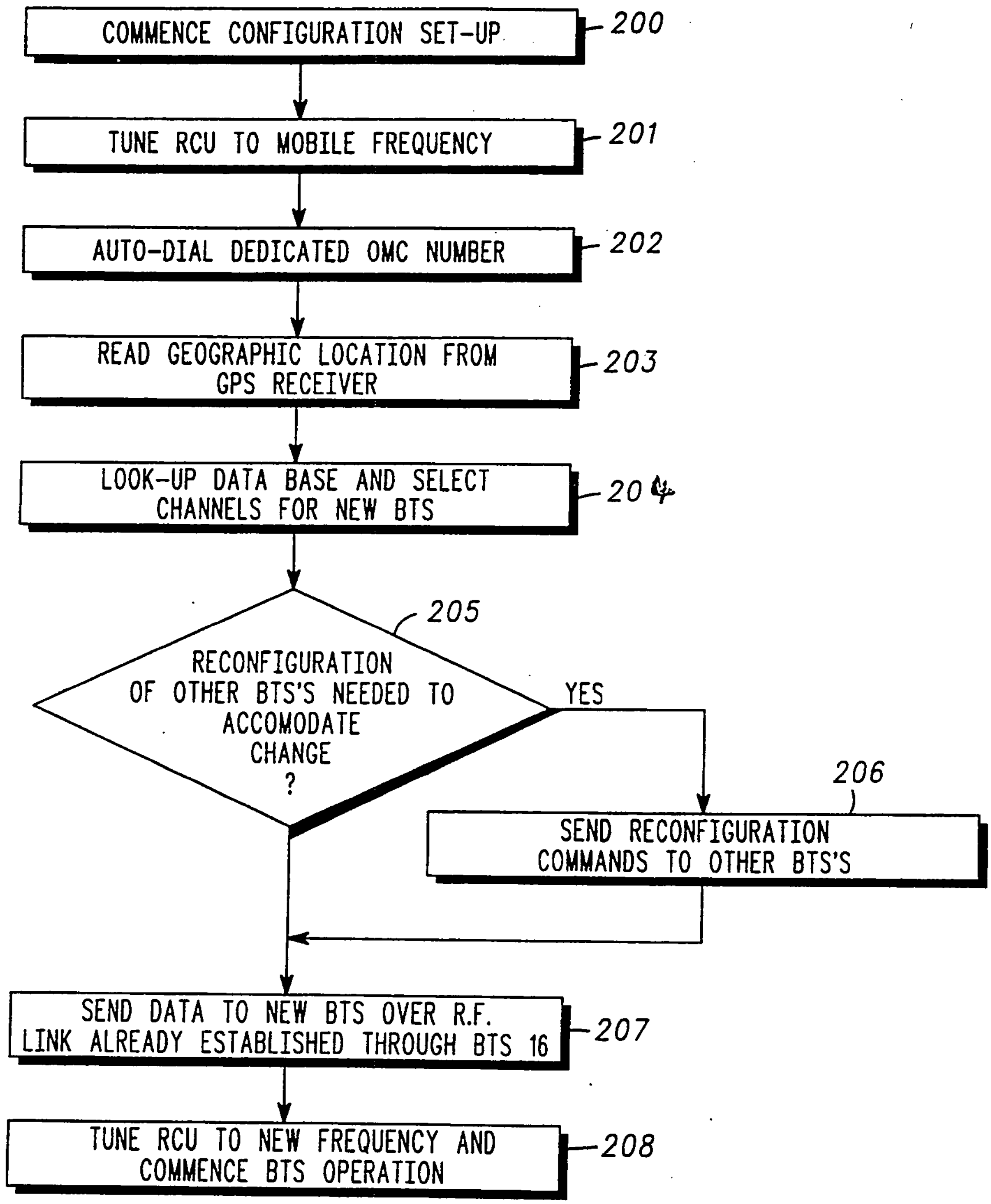
COMMENCE CONFIGURATION SET-UP
200
TUNE RCU TO MOBILE FREQUENCY
201
AUTO-DIAL DEDICATED OMC NUMBER
202
READ GEOGRAPHIC LOCATION FROM GPS RECEIVER
203
LOOK-UP DATA BASE AND SELECT CHANNELS FOR NEW BTS
204
205
RECONFIGURATION OF OTHER BTS'S NEEDED TO ACCOMODATE CHANGE ?
YES
206
SEND RECONFIGURATION COMMANDS TO OTHER BTS'S
SEND DATA TO NEW BTS OVER R.F. LINK ALREADY ESTABLISHED THROUGH BTS 16
207
TUNE RCU TO NEW FREQUENCY AND COMMENCE BTS OPERATION
208

FIG.3

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CELLULAR RADIO SYSTEM

Field of the Invention

This invention relates to a cellular radio system and it relates to frequency allocation in such a system.

Background of the Invention

Cellular network configurations are generally defined by surveying and 'drive-testing' the areas in which base stations are to be installed. The optimum frequency plan, cell size and base transceiver station (BTS) placement are calculated manually. Each time a new BTS is to be installed the whole process is repeated.

The Operations and Management Centre (OMC) is a central management facility in the network. At the present time it is utilised for fault management, code loading, interrogations of network equipment etc. It has the capability to reconfigure each BTS etc in the system, but the parameters for this are entered manually.

It would be desirable to simplify and automate the configuration of a cellular network.

Summary of the Invention

According to the present invention, there is provided a cellular radio system comprising a plurality of base sites and a central processing unit connected to the base sites for controlling the base sites and receiving data from the base sites, wherein the central processing unit has terrain information for correlating a geographical location with frequency allocation information, characterised by means for receiving new location information from a first base site, means for conducting a comparison of that information with known location information and frequency allocation information for other base sites and controlling the first base site and/or the other base sites to adopt new frequencies as a result of said comparison.

The invention provides a system in which additional (mobile) base stations can communicate with an Operation and Management Centre and the network can automatically reconfigure itself to bring the additional base

stations into service, thereby adding additional capacity/coverage to the cellular systems.

By contrast to prior art systems in which a network is planned using maps and propagation surveys, the invention provides geographical location correlated with the frequency allocation information in a data base memory at the OMC or at some other location.

The means for receiving new location information may comprise means for receiving that information via one of the other base sites. This can be achieved, for example, by the first base site (the mobile or new base site) acting in the manner of a mobile and placing a call to one of the existing base sites and through that call instructing the system that it wishes to be allocated frequencies according to the network configuration.

It is normal for each base site to have base site frequencies for transmission and mobile frequencies for reception. In the preferred embodiment, the first base site further has means for transmitting on a mobile frequency and means for conveying the new location information over a mobile frequency to one of the base sites.

Brief Description of the Drawings

Fig. 1 shows a cellular radio network in accordance with the invention.

Fig. 2 shows details of elements of the network of Fig. 1 and

Fig. 3 shows a sequence of steps in the operation of the system of Fig. 1.

Detailed Description of the Drawings

Referring to Fig. 1, a cellular radio system is shown comprising a number of base transceiver stations, of which seven are shown 10 - 16. Each of these BTSs is connected by a high speed data link e.g. link 17 to an Operation and Management Centre (OMC) 18.

Also shown in the figure is a mobile or additional fixed bas^ station 20. This base station has associated with it a global positioning system (GPS) receiver 21.

Each of the BTSs 10 - 17 has a coverage area, that is to say serves a cell, shown by the hexagonal outline. BTS 20 is located in a position where it

will cover the area shown in the dotted hexagonal outline. It is shown as having a fixed (e.g. hard-line) link 22 to the OMC, though there are circumstances where this may not be the case. The task of the system in accordance with the preferred embodiment of the invention is to allocate a frequency to BTS 20, or a group of frequencies, so as to enable it to serve the cell shown in dotted outline without conflict with the frequencies allocated to the cells surrounding it. This is achieved as follows.

The mobile or additional BTS 20 sends a message to the OMC 18 over the link 22. If no link exists, it temporarily acts as a mobile unit by making a call into the system via base station 16. This call is a dedicated set up call addressing the OMC 18. As an alternative to an end-to-end call, a paging type short message service data packet can be sent to the OMC over a control channel.

In sending this message to the OMC 18, the BTS 20 extracts from the GPS receiver 21 exact geographical location information. This information is sent to the OMC 18. The OMC performs a look-up operation in a data base 19. The data base 19 stores information which correlates geographical positions with frequencies and power levels allocated to base stations. Thus, data base 19 contains the geographic locations of each of the BTSs 10 - 16 and against each geographic location it correlates the allocated frequencies to that base station. Thus data base 19 contains a complete network plan. In order to select an appropriate frequency or set of frequencies for the BTS 20, the OMC 18 ascertains that the new cell will overlap with the cells served by BTSs 10, 11, 12 and 16. As a first step, therefore, the OMC eliminates the frequencies of those cells when considering appropriate frequencies to allocate to BTS 20. The OMC selects available frequencies for use by the BTS 20. The particular manner of selection of these frequencies depends upon a number of factors, such as the reuse pattern for the cells, the total number of frequencies available etc. In the arrangement shown, it may, for example, be quite acceptable to allocate BTS 20 the same channels as are allocated to BTS 14. This, in fact, is unlikely to be the best selection because the boundaries of cells are not precisely defined, in practice there will generally be sufficient frequencies available for the OMC 18 to select a frequency for BTS 20 which is not reused within the illustrated set of 7 cells.

Having selected an appropriate set of frequencies for use by BTS 20, the OMC sends (or transmits via BTS 16) a message to BTS 20 instructing BTS 20 to commence operation on the allocated set of frequencies. At the

same time the OMC 18 can send additional instructions to BTSs 10, 11 and 12 to cause them to be reallocated with completely new sets of frequencies. This may, for example, be necessary to avoid adjacent channel interference problems.

Once BTS 20 has been allocated its frequencies, it can commence operation as a base station. The link 22 connects the new BTS 20 to a communication network (not shown) such as a public switched telephone network. Alternatively, BTS20 can operate as a pure repeater between different mobiles in the field or between a mobile and the BTS 16.

After the BTS 20 has been configured in the network, the GPS receiver 21 can be detached from the BTS 20 for use in commissioning another BTS.

In an alternative embodiment, the BSC 16 stores enough local information to perform a calculation itself as to what frequencies to allocate to BTS 20. It can allocate those frequencies and report to the OMC 18 the changes it has made.

Referring to Fig. 2, details of the BTS 16 are shown. The BTS 20 has the same construction. Accordingly, Fig. 2 also shows details of the BTS 20.

The BTS 16 comprises a base station controller 100 connected through an EI CEPT interface 101 to a bus 102. Instead of an EI CEPT interface, a Basic Rate ISDN or TI CEPT interface may be provided. Connected to the bus 102 is a processor 103 for overall control of the BTS. One or more digital radio interfaces (DRI) 104 and 105 are connected to the bus 102 and for each DRI is a radio communication unit 106, 107 connected thereto. The or each RCU is connected via a radio frequency combiner 110 to an antenna 111. In the case of the BTS 20 there is a GPS interface 120 to which can be connected the GPS receiver 21.

Each RCU 106 has a dedicated transmit frequency and a corresponding dedicated receive frequency at 45MHz separation from the transmit frequency. Alternatively, the or each RCU can hop through a number of different transmit and receive frequency pairs. Hopping will not be considered here in detail. All the principles which apply to the planing and configuring of a network for a single frequency apply equally to the case of hopping through a number of frequencies.

When the base station 16 is initially configured on the network, a command is received from the OMC through the BSC 100 and the MSI 101 to the processor 103. The command is a configuration command containing a

frequency or set of frequencies to be used by the or each RCU 106, 107. The processor 103, controlling the RCU 106 over the bus 102, causes the RCU 106 to tune that allocated frequency for transmission (and the corresponding frequency for reception). Thereafter communication can take place between the antenna 111 and the BSC 100 and from the BSC 100 to a Master Switching Centre (MSC) and a public switched telephone network (not shown). The BSC is capable of identifying an incoming call which is dedicated to the OMC, or is capable of routing short message service data intended for the OMC directly to that destination.

In the case where the apparatus of Fig. 2 is the BTS 20, the task exists of selecting the appropriate frequencies for the or each RCU 106, 107.

The processor for selecting these frequencies is shown in Fig. 3. As shown in that figure, configuration set up is commenced at step 200 by keying into an input device at the BTS 20 a suitable configuration set up command. This command causes the processor 103 to tune the RCU 106 to a transmit frequency normally dedicated to a mobile unit and to a corresponding receive frequency (step 201). The sequence automatically proceeds by the auto-dialling in step 202 of a dedicated OMC number. It will be appreciated that this step can be replaced by the transmission of a short message service data packet on a control channel. In the course of this transmission, the geographic location of the BTS 20 is read from the GPS receiver 21 (step 203) and this is transmitted to the OMC 18 over the established RF link. At the OMC, a look-up operation is performed in data base 19 to select appropriate channels for the new BTS 20 (step 204). At the same time the OMC 18 determines whether the other BTSs 10, 11, 12 etc need to change their frequencies or power levels to accommodate the change (step 205). If they do indeed need to reconfigure, commands are sent out from the OMC 18 to the various BTSs 10, 11, 12 etc (step 206) and these various BTSs receive those commands at their various processors and cause their various RCUs to retune to the new frequencies. If there are on going calls to mobiles in the cells covered by those base stations, those mobiles will experience sudden deterioration of their serving signals and will perform hand-off operations to new channels. It can be arranged that the change from the old frequencies to the new frequencies is performed by a gradual reduction in power so that the hand-over is reasonably graceful. Following step 205 and, if necessary step 206, step 207 takes place in which data is sent from the OMC 18 to the new

BTS 20 over the RF link established in step 202 through the BTS 16, and the BTS 20 is informed as to the new frequency or frequencies (and power levels if necessary) to be used by the or each RCU 106, 107 of the BTS 20. Finally in step 208, the processor 103 of the BTS 20 causes the or each RCU 106, 107 to tune to the new frequencies. Thereafter regular BTS operation can commence, with BTS 20 acting as a repeater or, if provided with a link to the OMC, acting as a regular base station.

The arrangement described has particular advantages in military applications where new cellular radio telephone systems need to be deployed rapidly across territory that may have been recently occupied. The BTS 20 can be located in a vehicle and the entire system can expand and move across geographic terrain constantly, with each move being accompanied by a command to reconfigure the entire network according to the new locations of the base stations and the presence of existing base stations across the terrain. The OMC constantly maintains an up-to-date record of locations of base stations and frequencies allocated to those base stations.

A military tactical system may be arranged such that only the rearmost BTS has a landline and all other BTSs repeat messages from the front line BTSs. Inter-BTS communication could be mobile-mobile or some other communication link, e.g. microwave, satellite, etc.

comparing that geographic location with information (19) stored at the central control unit which correlates geographic location information of other base stations (10-16) with frequencies allocated to those other base stations,

selecting at least one frequency for allocation to the first base station,

sending information identifying the at least one frequency to the first base station and

controlling the first base station to select said at least one frequency for communication in response to the information received and

commencing radio operation of the new base station on the selected frequency.

6. A method according to claim 5 comprising the further step of sending frequency allocation information to at least some of the other base stations (10 - 16) and controlling those base stations to select new frequencies for communication.

7. A method according to claim 6 wherein the step of selecting the new frequencies for operation comprises the step of gradually reducing any communications on the existing frequencies prior to selection of the new frequencies.

CLAIMS

1. A cellular radio system comprising a plurality of base sites (10-16) and a central processing unit (18) connected to the base sites for controlling the base sites and receiving data from the base sites, wherein the central processing unit has terrain information (19) for correlating a geographical location with frequency allocation information, characterised by means for receiving new location information from a first base site (20), means for conducting a comparison of that information with known location information and frequency allocation information for other base sites and controlling the first base site and/or the other base sites to adopt new frequencies as a result of said comparison.

2. A cellular radio system according to claim 1, wherein the first base site (20) has a radio transceiver (106, 107) for conducting radio communications with mobile units and the means for receiving new location information comprise a link (22) between the first base site and the central processing unit (18) which is additional to said radio communications conducted by said transceiver.

3. A cellular radio system according to claim 1, wherein the means for receiving new location information comprise means for receiving said information via one of said other base sites (16).

4. A cellular radio system according to claim 3, wherein each base site comprises means (106, 107) for transmitting on base site frequencies and receiving over mobile frequencies which differ from the base site frequencies, characterised in that the first base site (20) further comprises means for transmitting on a mobile frequency and means for conveying the new location information over a mobile frequency to one of the base sites.

5. A method of operation of a cellular radio system comprising the steps of transmitting geographic information from a first base station (20) requiring frequency allocation to a central control unit (18) of the system,

Patents Act 1977
Examiner's report to the Controller under Section 17
(The Search report)

-9-

Application number
GB 9317834.1

Relevant Technical Fields

(i) UK Cl (Ed.L) H4K: (KY4D8, KY4D8D) H4L: (LDSF, LDSX)

(ii) Int Cl (Ed.5) H04Q 7/04

Search Examiner
JOHN CAGE

Date of completion of Search
4 NOVEMBER 1993

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE : WPI

Documents considered relevant following a search in respect of Claims :-
1-7

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
A	EP 0490554 A2	(AT & T) - see column 4 lines 37-55	
A	WO 92/21182 A1	(TELEFONAKTIE-BOLAGET) - see abstract and page 19 lines 14-22	

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).